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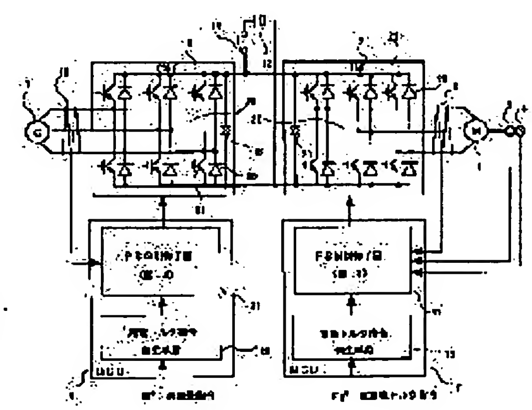
(54) HYBRID DRIVE SYSTEM FOR ELECTRIC CAR

(57)Abstract:
PROBLEM TO BE SOLVED: To make a generator control system highly responsive for charging a battery, almost equal to that of a motor control system for motor vehicle driving by providing the same main circuit configuration for each reverse converter and forward converter as the power converters for driving AC machines used for motors and generators.
SOLUTION: A motor 1 is a permanent magnet-type synchronous motor, and as a power converter, it is a reverse converter, that is, an inverter. A generator 7 is a permanent magnet-type synchronous generator and uses a forward converter, that is, a converter as a power converter. Here, the inverter and converter have the same main circuit configuration. That is, the inverter and converter are respectively constituted with 6 power elements 21, 81 and diodes 20 and 80 connected in parallel to each power element. Moreover it is equipped with three-phase bridge circuits 22 and 82, controlling currents flowing to the winding of each phase of U, V, W or motor 1 or generator 7 and one pair of smoothing capacitors 23, 83.



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CLAIMS

[Claim(s)]
[Claim 1] The AC generator driven with an engine, and the AC motor for a car drive which uses said generator or dc-battery as a main power supply, In the hybrid drive system for electric rolling stock which consisted of drive circuits of said generator containing a power converter, and said motor said power converter The hybrid drive system for electric rolling stock characterized by being arranged between said generators and said dc-batteries, and consisting of a rectification machine which changes an alternating current into a direct current, and an inverter which is arranged between said motors and said dc-batteries, and changes a direct current into an alternating current, and consisting of same main circuit configurations.
[Claim 2] The hybrid drive system for electric rolling stock characterized by constituting said main circuit from a three-phase-circuit BURITCHI circuit using six power components in the hybrid drive system for electric rolling stock according to claim 1.
[Claim 3] The hybrid drive system for electric rolling stock characterized by making the same the modulation technique of the power component of said main circuit in the hybrid drive system for electric rolling stock according to claim 1.
[Claim 4] The hybrid drive system for electric rolling stock characterized by making it dq shaft current control which shows the current control system of said AC motor and an AC generator of the same excitation component and a torque component in the hybrid drive system for electric rolling stock according to claim 1.
[Claim 5] The hybrid drive system for electric rolling stock characterized by constituting said main circuit from a three-phase-circuit BURITCHI circuit using six power components, making the modulation technique of said power component the same in the hybrid drive system for electric rolling stock according to claim 1, and making it dq shaft current control which shows the current control system of said AC motor and an AC generator of the same excitation component and a torque component.
[Claim 6] The hybrid drive system for electric rolling stock characterized by making the same the response characteristic of dq shaft current control system of said both transducers in the hybrid drive system for electric rolling stock according to claim 1.
[Claim 7] The hybrid drive system for electric rolling stock characterized by generating the phasing signal which an engine uses by current control processing based on the zero detecting signal of the induced voltage of said generator in the state of an idling as a current control system of said AC generator in the hybrid drive system for electric rolling stock according to claim 1.
[Claim 8] The hybrid drive system for electric rolling stock characterized by creating the phasing signal used by current control processing as a current control system of said AC generator using the phasing signal of the alternating-voltage command signal which is the in-house data of dq shaft current control processing by the generation-of-electrical-energy control state in the hybrid drive system for electric rolling stock according to claim 1.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Especially this invention relates to the hybrid drive system constituted from the gasoline engine, a generator, a motor, and a dc-battery with respect to hybrid drive electric rolling stock.
[0002]
[Description of the Prior Art] The hybrid drive system for electric rolling stock consists of each drive circuit of the motor for a car drive which generally uses as a power source the generator driven with an engine, a dc-battery, and a generator or a dc-battery, and a generator and a motor, and has the composition that each drive circuit contains a power converter. The parallel mold with which parallel connection of the series mold with which the series connection of an engine, a generator, and the motor is carried out, and an engine, a generator and a motor is carried out as a drive method of a car is known. In a series mold, a car is always driven with a motor, and while acquiring the power source of a motor from the generator connected to the dc-battery or the engine, a dc-battery is charged with the generator connected to the engine. On the other hand, in a parallel mold, a car drives with a motor or an engine and the power source of a motor is acquired from a dc-battery.
[0003] There are some which were indicated by JP,7-336809,A as a well-known example of this kind of hybrid drive system. The above-mentioned well-known example is the hybrid drive system of a series mold, and has the composition of charging a dc-battery by the engine, the generator, and the diode rectifier circuit. The output response characteristic of a generator is decided by engine responsibility and the responsibility of the field current of a generator with this configuration.
[0004] Generally, compared with an electrical machinery and apparatus, the speed of response of an engine is slow. Moreover, the generator of a field mold has response delay peculiar to a field winding. Therefore, it is thought that the responsibility of a generator control system is low and high response-ization cannot be expected compared with the responsibility of the motor control system constituted from the drive circuit and inverter of a motor.
[0005] Moreover, for current control of an AC generator, in order to use the output of an angle sensor or a magnetic pole location sensor, the configuration of a generator control system becomes complicated and needs the installation tooth space.
[0006]
[Problem(s) to be Solved by the Invention] The purpose of this invention is in a hybrid drive system to form into a high response the generator control system which charges a dc-battery to the motor control system and EQC for a car drive. Other purposes of this invention are shown in simplifying the configuration of a generator control system and attaining space-saving-ization in a hybrid drive system.
[0007]
[Means for Solving the Problem] In the hybrid drive system for electric rolling stock which consisted of the generators, the dc-batteries, and the motors for a car drive which were connected to the engine, the description of this invention uses an AC machine for a motor and a generator, and is in the inverter as a power converter which drives these AC machines, and the hybrid drive system which considered the rectification machines of each as the same main circuit configuration.
[0008] Other descriptions of this invention are in the above-mentioned hybrid drive system to consider as the three-phase-circuit BURITCHI circuit using six power components as a main circuit configuration.
[0009] Other descriptions of this invention are in the above-mentioned hybrid drive system to make the same the modulation technique of the power component of these main circuits.
[0010] Other descriptions of this invention are in the above-mentioned hybrid drive system to consider as dq

shaft current control which shows the current control system of an AC motor and an AC generator of the same excitation component and a torque component.
[0011] Other descriptions of this invention are in the above-mentioned hybrid drive system to make the same the response of the dc-component current control system of both converters.
[0012] Other descriptions of this invention are in the above-mentioned hybrid drive system to create the phasing signal for which an engine uses the induced voltage of a generator by current control processing using the phasing signal of the alternating-voltage command signal which is the in-house data of dq shaft current control processing in the state of an idling by the generation-of-electrical-energy control state.
[0013] according to this invention, it becomes possible to form into a high response the response of the generator control system which charges a dc-battery to same extent as the motor control system for a car drive by having considered the inverter which drives an AC machine, and the power converter of each rectification machine as the same main circuit configuration.
[0014] Moreover, the control system of the same above-mentioned main circuit configuration also becomes possible [forming further into a high response the response characteristic of the generator control system which charges a dc-battery] by supposing that it is the same. Moreover, space-saving-ization of a hybrid drive system is attained by considering as the sensor loess control which does not use the rotation sensor which constitutes the current control system of an AC generator from an angle sensor or a magnetic pole location sensor.
[0015]
[Embodiment of the Invention] Hereafter, drawing explains the example of this invention. First, drawing 1 shows the series mold hybrid drive structure of a system for electric rolling stock which becomes one example of this invention. A motor 1 is a permanent-magnet type synchronous motor, and uses an inverter 2, i.e., an inverter, as a power converter. The magnetic pole position transducer 4 which detects the encoder 3 and magnetic pole location which are the angle-of-rotation sensor is directly linked with the permanent-magnet type synchronous motor 1. The motor control unit (MCU) 5 generates an PWM signal based on the output of an encoder 3 and the magnetic pole position transducer 4, and the output of the current detector 6, and controls an inverter 2. A generator 7 is a permanent-magnet type synchronous generator, and uses the rectification machine 8, i.e., a converter, as a power converter. The generator control unit (GCU) 9 generates an PWM signal based on the output of the current detector 10, and controls a converter 8. Let the generator control unit 9 be the sensor loess control system which does not attach a rotation sensor in the permanent-magnet type synchronous generator 7.
[0016] In the series mold hybrid drive system of drawing 1 , electric rolling stock is obtained from the permanent-magnet type synchronous generator 7 which always drives with the permanent-magnet type synchronous motor 1, and drives the power source of this motor 1 by the dc-battery 12 or the gasoline engine 11. Moreover, a dc-battery 12 is charged with the permanent-magnet type synchronous generator 7. An engine 11 is controlled by the engine control unit (ECU) 13. 14 is a contactor and 30 is a wheel.
[0017] The hybrid drive system control section 15 responds to the control input of the accelerator pedal 16 and the brake pedal 17, and is motor torque command tauM* to the motor control unit 5. It controls so that delivery and a motor 1 generate the torque corresponding to the control input of the accelerator pedal 16 and the brake pedal 17. The hybrid drive system control section 15 is generation-of-electrical-energy command KW* and engine-speed command NE* to the generator control unit 9 and the engine control unit 13 again, respectively. The amount of generations of electrical energy of a generator 7 and the rotational frequency of an engine 11 are controlled so that predetermined power is supplied to delivery, a dc-battery 12, or a motor 1.
[0018] As shown in drawing 2 , the inverter 2 and the converter 8 have the same main circuit composition. That is, the inverter 2 and the converter 8 were constituted by six power components (IGBT) 20 and 80 and each power component using the diodes 21 and 81 connected to juxtaposition, respectively, and are equipped with the three-phase-circuit BURITCHI circuits 22 and 82 which control the current which flows to the coil of U [of a motor 1 or a generator 7], V, and W each phase, and one smoothing capacitors 23 and 83. However, since the capacity of an inverter 2 has one several times the capacity of a converter 8 of this, the capacity of each element (21, and 81, 23 and 83) which constitutes a main circuit differs, respectively.
[20, 80,]
[0019] The motor control unit 5 generates the PWM signal which controls the power component of an inverter 2 based on the current detector 6, the magnetic pole location detection means 4 and each detection value of an encoder 3, and torque command value tauM* sent from the torque command generating means 18.

[0020] The block diagram of internal processing of the motor control unit 5 is shown in drawing 3 . The motor control unit 5 is equipped with the IdIq detector 202, the IdIq current control means 204, the 2 / three-phase-circuit conversion means 206, the PWM control means 208 and the phase operation means 210, and the rate operation means 212. The rate operation means 212 is connected to an encoder 3, and the phase operation means 210 is connected to the magnetic pole location detection means 4. The motor control unit is further equipped with the Iq control means 224 and the Id control means 226.
[0021] Command value Iq* of q shaft current which is equivalent to a torque part current in the motor control unit 5 Torque command value tauM* It computes by the Iq control means 224 for computing on a basis. On the other hand, command value Id* of d shaft current is computed through the Id control means 226 based on the rotational frequency calculated with the rate operation means 212 from the pulse signal from torque command value tauM* and an encoder 26. Thus, Id in a motor control unit and Iq control means are current command value Iq* required for efficient control, and Id* based on a rotational frequency. It computes.
[0022] The IdIq detection means 202 performs coordinate transformation processing of a three phase circuit/2 phase about the three-phase-circuit alternating current of the motor current detected with the current detector 6, and computes d and the q shaft currents Id and Iq. These detection values and command value Iq*, and Id* On a basis, the IdIq current control means 204 performs proportionality or proportional integral current control processing, and computes electrical-potential-difference command value Vq* and Vd*.
[0023] Furthermore, in 2 / three-phase-circuit conversion means 206, 2 phases / three phase circuit carries out coordinate transformation, and they are three-phase-circuit alternating-voltage command value VU*, VV*, and VW*. It computes. the PWM control means 208 -- this electrical-potential-difference command value VU*, VV*, and VW* from -- comparison processing with the carrier signal of a triangular wave signal is performed, the PWM signal of an inverter 2 is generated, and an inverter 2 is driven. Thus, by impressing the electrical potential difference by which PWM control was carried out to a motor 1, it is a motor current Current command value Iq* and Id* It controls.
[0024] In addition, the phase angles theta1 and theta2 used by 2 / three-phase-circuit transform processing 206, and coordinate transformation processing of the IdIq detection means 202 are computed in the phase operation means 210 from the induced voltage of a motor 1, and each output of the magnetic pole position transducer 4 which outputs a signal in phase, and the encoder 3 which outputs an angle-of-rotation signal (pulse signal).
[0025] The phase relation between the output signal of this magnetic pole position transducer 4 and the phase angles theta1 and theta2 of the motor control unit 5 interior to the motor current I1 and induced voltage E0 is shown in drawing 5 . A phasing signal is calculated with a phase operation means 210 to accumulate the pulse signal of an encoder 3, and turns into a saw-tooth-wave-like signal. The magnetic pole position signal which is an output signal of the magnetic pole position transducer 4 is synchronized with the induced voltage E0 of a motor 1. By performing such processing, a motor 1 is torque command value tauM*. It is controlled by the well head which is torque and makes loss min.
[0026] The vector diagram of the motor 1 at that time is shown in drawing 6 . Iq* for acquiring an efficient point, and Id* It is controlled by optimal angle-of-lead beta (beta=tan -1 (Id*/Iq*)). In addition, it is the reference point of angle-of-lead beta at the t0 time shown in drawing 5 , and it shows the current I1 currently controlled at this t0 time with a broken line.
[0027] The output torque of a motor 1 is shown by (1) type.
[0028]
tauM=Pn [{E0+(1-rho) LdId} Iq] -- (1)
However, Pn of a constant and rho is [the ratio of Lq and Ld and E0] induced voltage.
[0029] (1) In the formula, the 1st term of the right-hand side is called synchronous torque, and the 2nd term is called reactance torque.
[0030] The torque characteristic which considered as the applied-voltage regularity to a motor, and made angle-of-lead beta adjustable comes to be shown in drawing 7 . The sum of synchronous torque and reactance torque is generating torque tauM. Thus, since angle-of-lead beta generates the maximum torque near 45 degrees, the synchronous motor in which rho of (1) type has a larger reverse salient pole property than 1 is controlled above this include angle. An electric vehicle is driven in such actuation.
[0031] Drawing 4 is the block diagram showing the example of a configuration of the generator control unit 9. The generator control unit 9 is equipped with the IdIq detector 302, the IdIq current control means 304, the 2 / three-phase-circuit conversion means 306, the PWM control means 308 and the phase operation

means 310, and the rate operation means 312. The input signal of the phase operation means 310 and the rate operation means 312 is alternatively connected to a zero detector 316 or 318 through the mode change means 314 which changes idling mode and generation-of-electrical-energy mode. It is alternating-voltage command value VU* whose zero detector 316 is the output of 2 / three-phase-circuit conversion means 306 at the time of generation-of-electrical-energy mode. A zero crossing point is detected. Moreover, a zero detector 318 detects the zero crossing point of the induced voltage of the generator obtained from the outgoing end 319 of a generator 7 in idling mode.

[0032] The generator control unit 9 is further equipped with the Iq control means 324 and the Id control means 326. The torque command generating means 19 is amount command KWof generations of electrical energy *. Torque command tauG*=kxKW*/NG is generated based on the generator rotational frequency NG calculated with the rate operation means 312. However, k is a constant.

[0033] Command value Iq* of q shaft current which is equivalent to a torque part current in the generator control unit 9 Torque command value tauG* It computes by the Iq control means 324 based on the generator rotational frequency NG. Moreover, command value Id* of d shaft current Torque command value tauG* Based on the rotational frequency NG calculated with the rate operation means 312, it computes through the Id control means 326.

[0034] The Iq control means 324 in the generator control unit 9 and the Id control means 326 are current command value Iq* required for efficient control, and Id* based on a rotational frequency NG. It computes. In addition, in this invention, sensor loess control is adopted in consideration of the space factor to which circuitry was simply carried out and the engine room was restricted. That is, the rate NG of a generator 7 is not detected using a rotation sensor, but data processing of it is carried out as follows, and it is found. First, when a shift switch is in idling mode, an engine is an idling engine speed, suspends a converter 8 and does not perform generation-of-electrical-energy control. At this time, a phase operation and a rate operation are performed based on the zero detecting signal of the induced voltage of the generator obtained from the outgoing end 319 of a generator 7. Since it changes to generation-of-electrical-energy mode at the time of a rotational frequency with a bigger engine than an idling engine speed and it considers as generation-of-electrical-energy control initiation, the phase operation means 310 is alternating-voltage command Vu*. A phase operation is performed on a basis. Thus, alternating-voltage command Vu* which is the in-house data of a dc component, i.e., dq shaft current control processing, as a current control system of said AC generator The phasing signals E1 and E2 used by current control processing are created using a phasing signal.

[0035] It computes d and the q shaft currents Id and Iq by a phasing signal theta 2 being used for the IdIq detection means 302 based on the three-phase-circuit alternating current of a generator current, and a three phase circuit/2 phase carrying out coordinate transformation. These detection values and command value Iq*, and Id* The IdIq current control means 304 performs proportionality or proportionality integral compensation processing on a basis, and they are electrical-potential-difference command value Vq* and Vd*. It computes.

[0036] Furthermore, in 2 / three-phase-circuit conversion means 306, coordinate transformation processing of 2 phases / three phase circuit is performed using a phasing signal theta 1, and they are three-phase-circuit alternating-voltage command value VU*, VV*, and VW*. It computes. the PWM control means 308 -- this electrical-potential-difference command value VU*, VV*, and VW* from -- comparison processing with the carrier signal of a triangular wave signal is performed, the PWM signal of a converter 8 is generated, and a converter 8 is driven. Thus, by impressing the electrical potential difference by which PWM control was carried out to a generator, it is a generator current Current command value Iq* and Id* It controls.

[0037] Next, actuation of sensor loess generator control is explained using drawing 10 from drawing 8 . The vector diagram of a generator 7 is shown in drawing 8 . A generator system makes regeneration actuation perform to a motor system, and charges a dc-battery 12. Therefore, negative and angle-of-lead beta are 90 degrees or more in an electrical angle, and the q shaft current Iq operates. Furthermore, the generator terminal voltage V1 is behind only in the phase angle delta to induced voltage E0.

[0038] As shown in drawing 9 , it is three-phase-circuit alternating-voltage command value VU*. The zero detection means 311 detects zero crossing point t. The phase operation means 310 computes the phasing signal theta 1 in which only the phase angle delta was to magnetic pole position signal PS-U (U phase signal) of imagination by amending a phasing signal theta 1 to theta11 and theta12 by zero crossing points t1 and t2. d shaft current control system of drawing 4 controls the generator current iu on the current to which only angle-of-lead beta (beta=ATAN (Id/Iq)) progressed to virtual signal PS-U, and makes generator control action perform based on this phasing signal theta 1.

[0039] As shown in drawing 10 , the sensor loess generator control of the phase angle delta is attained by

calculating the value of the phase angles delta1 and delta2, map-izing for the phase operation means 310, and carrying out storage maintenance beforehand, to the amount P of generations of electrical energy. In the phase angle property of drawing 10 , at the same rotational frequency, when small, the phase angle delta becomes [the amount P of generations of electrical energy] small like an arrow head. If the rotational frequency (min-1) of amount command KWof generations of electrical energy * and a generator is given, it will ask by count. And phase theta1=0 or theta 2, i.e., the phase of induced voltage E0, is presumed, and they are current Iq* and Id*. The phasing signal beta used by control processing is created.
[0040] The vector diagram of the generator at this time is shown in drawing 8 . It is a generator current in order to always acquire an efficient point by each operation mode of power running or regeneration Current command value Iq* and Id* It controls. Namely, Iq* and Id* It is controlled to be set to optimal angle-of-lead beta (beta=tan -1 (Id*/Iq*)). In addition, it is the reference point of angle-of-lead beta at the t0 time shown in drawing 9 .
[0041] Return and the hybrid drive system control section 15 are engine-speed command NE* to the engine control unit 13 in drawing 1 . It takes out, and it controls so that an engine becomes a predetermined rotational frequency. Moreover, it responds to the control input of the accelerator pedal 16, and is motor torque command tauM* to the motor control unit 5. It sends. Moreover, to the control input of the accelerator pedal 16, the condition of a dc-battery 12 is embraced and it is engine-speed command NE*. Amount command KWof generations of electrical energy * of the generator control unit 9 The control input of delivery and the accelerator pedal 16 operates a motor 1 in power running mode to each units 9 and 13 at an increment or the fixed time, and charges a dc-battery 12 at them, and the acceleration nature of a car is raised.
[0042] When the control input of the accelerator pedal 16 decreases, a motor 1 is operated in regeneration mode and actuation which stops charge actuation of a dc-battery 12 is made to perform.
[0043] In this invention, the modulation technique of the power component of a converter 8 is the same method as the case of an inverter 2 like for example, an PWM signal system a passage clear from the example described above. Moreover, the generator control units 9 are the same configuration as the motor control unit 5, and a control system. That is, the motor control unit 5 and the generator control unit 9 are considered as dq shaft current control which makes the same the current control system of an AC motor and an AC generator, and shows a current control system of an excitation component and a torque component. By considering as the above configurations and control systems, the response of dq shaft current control system of both converters is made the same, or can be chosen as the property of arbitration. By performing the above configuration and actuation, it is possible to form into a high response the response of the generator control system which charges a dc-battery to the motor control system and EQC for a car drive.
[0044] Drawing 11 and drawing 12 show the responsibility of this invention, the motor control system by the conventional example, and a generation-of-electrical-energy control system.
[0045] First, drawing 11 shows the property and operation pattern of an AC motor which are used in order to compare responsibility. The torque corresponding to the load characteristic it is decided in an A point with NMA and road surface inclination that the rotational frequency of an AC motor will be assumes by tauMA that it is under transit. Drawing 12 assumes the middle acceleration which breaks in an accelerator pedal further from the condition of drawing 11 .
[0046] At this time, the situation of a car drive system is as being shown in drawing 12 . A continuous line shows this invention and the broken line shows the conventional example. The engine rotational frequency is always uniformly controlled by NG like drawing 12 (a). When it gets into the accelerator pedal 16 like (f) at the t0 time, a motor is torque command tauM* for acceleration. It is made to increase with tauMA, tauMB, and tauMC, and as shown in (d), a motor rotational frequency is increased to NMB at the t1 time. That is, the torque of a motor increases temporarily, as shown in (e), it decreases after that, and balances by tauMB. On the other hand, it is amount command KWof generations of electrical energy *. As shown in (b), it starts quickly. At this time, with the increment in a load, battery voltage VB decreases a little, as shown in (c).
[0047] Since the response characteristic of a motor control system and a generation-of-electrical-energy control system can be made almost the same according to this invention, even if it carries out middle acceleration from an engine speed NMA, there is no big depression of battery voltage since it charged promptly so that it might become power required for acceleration, as showed the dc-battery to drawing 12 (d) with the broken line, the engine speed and torque of a motor can be increased smoothly, and high acceleration responsibility is acquired.
[0048] Since equivalent responsibility is not acquired compared with the responsibility of a motor control

system as the broken line, on the other hand, showed the generation-of-electrical-energy control system which carries out adjustable [of the generation-of-electrical-energy electrical potential difference] by the field winding to drawing 12 in the conventional example, a high-speed response is not expectable that a broken line shows.

[0049] Drawing 14 shows the example which applied this invention to the parallel mold hybrid drive system configuration for electric rolling stock, and drives a car with the driving force of a gasoline engine, and the driving force of a motor drive system. 31 is a gearbox. It is possible by constituting, as the previous example described the motor control unit 5 and the generator control unit 9 also in this example to form into a high response the response of the generator control system which charges a dc-battery to the motor control system and EQC for a car drive.

[0050]

[Effect of the Invention] according to this invention, by having used the generator and motor of a hybrid drive system as the AC machine, and having considered the inverter which drives these AC machines, and the power converter of each rectification machine as the same main circuit configuration, it becomes possible to form into a high response the response of the generator control system which charges a dc-battery to same extent as the motor control system for a car drive, and high acceleration responsibility is acquired.

[0051] Moreover, the control system of the same above-mentioned main circuit configuration also becomes possible [forming further into a high response the response characteristic of the generator control system which charges a dc-battery] by supposing that it is the same. Moreover, it becomes possible to attain space-saving-ization of a hybrid drive system by considering as the sensor loess control which does not use the rotation sensor which constitutes the current control system of an AC generator from an angle sensor or a magnetic pole location sensor.

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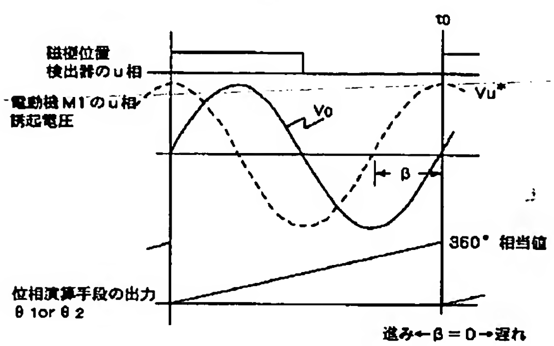
DRAWINGS

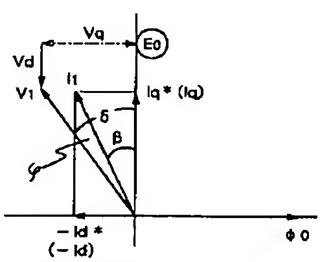
[Drawing 5]

図 5



[Drawing 6]

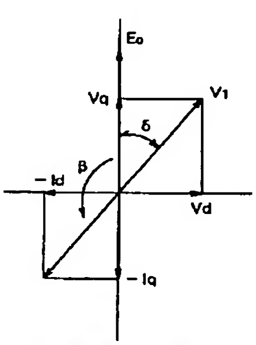
図 6



E0…磁石の誘起電圧 V1…端子電圧
δ…負荷角 φ…力率角 β…進み角

[Drawing 8]

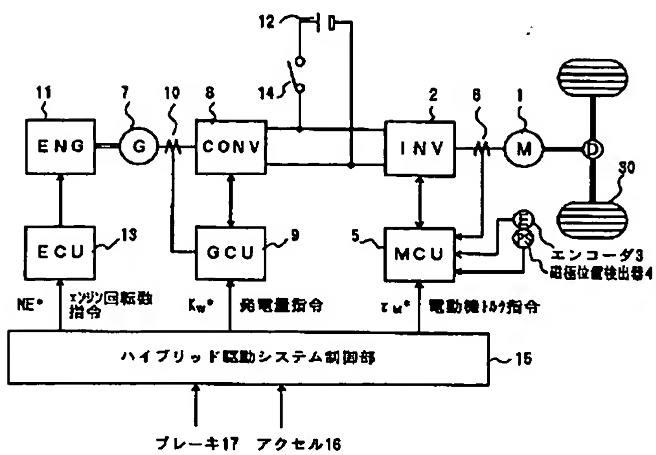
図 8



δ…相差角 β…進み角

[Drawing 1]

図 1



[Drawing 2]

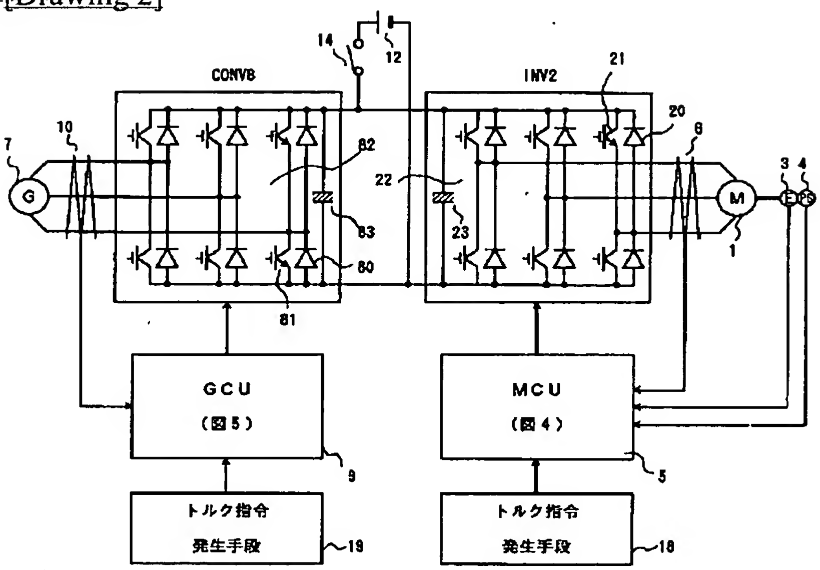
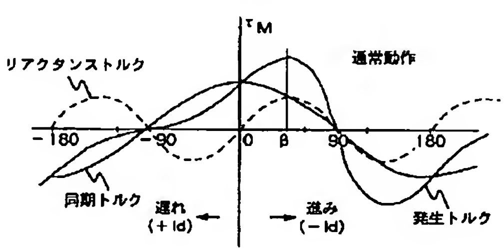


図 2

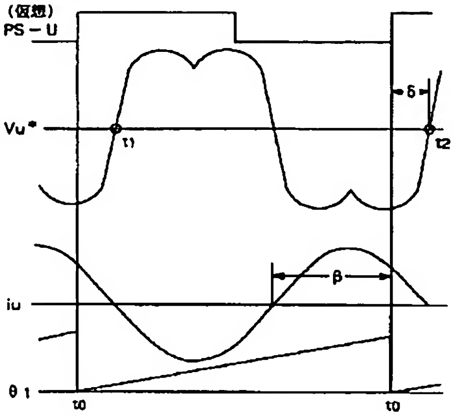
[Drawing 7]

図 7



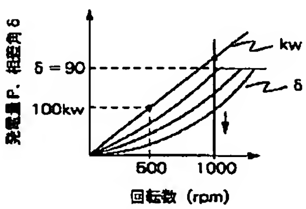
[Drawing 9]

図 9



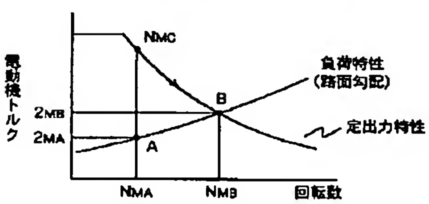
[Drawing 10]

図 10



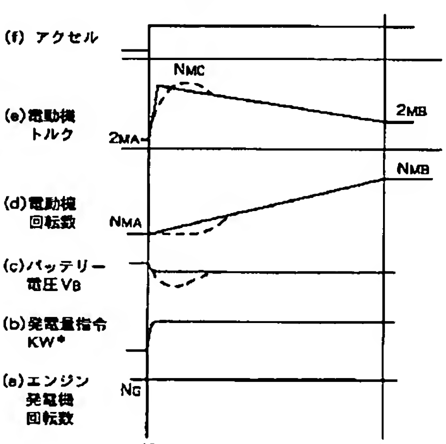
[Drawing 11]

図 11



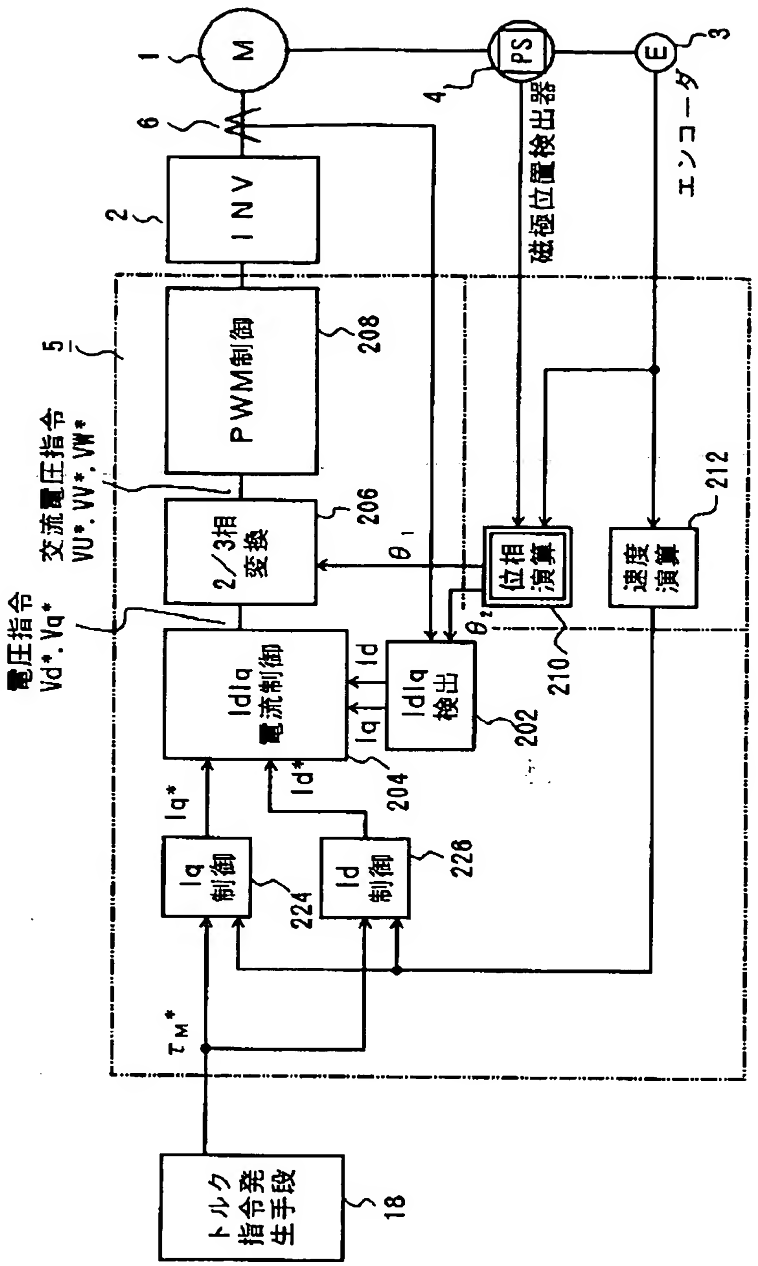
[Drawing 12]

図 12



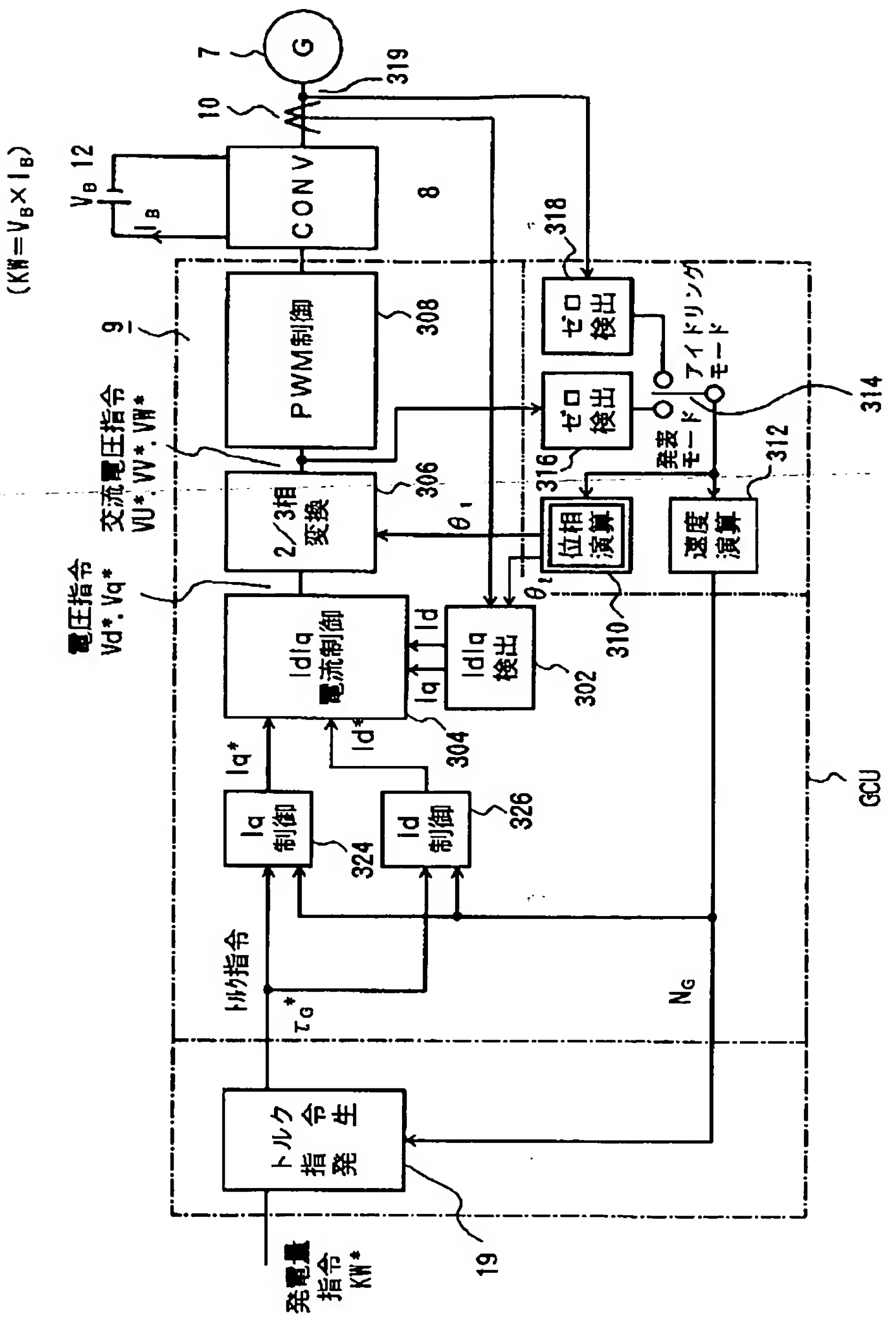
[Drawing 3]

図 3


M
1
PS
4
E
3
磁極位置検出器
エンコーダ
6
INV
2
5
PWM制御
208
交流電圧指令
VU*, VV*, VW*
2／3相変換
206
θ1
位相演算
210
速度演算
212
θ2
電圧指令
Vd*, Vq*
IdIq電流制御
204
IdIq検出
202
Id
Iq
Iq*
Id*
Iq制御
224
Id制御
228
τM*
トルク指令発生手段
18

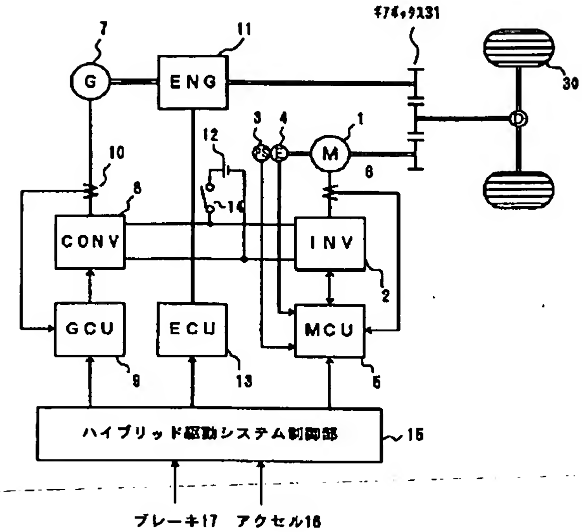
[Drawing 4]

図 4



[Drawing 13]

図 13



[Translation done.]

WRITTEN AMENDMENT

--- [a procedure revision]
[Filing Date] November 5, Heisei 8
[Procedure amendment 1]
[Document to be Amended] Specification
[Item(s) to be Amended] 0018
[Method of Amendment] Modification
[Proposed Amendment]
[0018] As shown in drawing 2 , the inverter 2 and the converter 8 have the same main circuit composition. That is, the inverter 2 and the converter 8 were constituted by six power components (IGBT) 21 and 81 and each power component using the diodes 20 and 80 connected to juxtaposition, respectively, and are equipped with the three-phase-circuit BURITCHI circuits 22 and 82 which control the current which flows to the coil of U [of a motor 1 or a generator 7], V, and W each phase, and one smoothing capacitors 23 and 83. However, the electrical potential difference of each element (21, and 81, 23 and 83) from which the capacity of an inverter 2 and a converter 8 constitutes a main circuit with the output capacitance of a motor 1 and a generator 7 differs from current capacity, respectively. [20, 80,]
[Procedure amendment 2]
[Document to be Amended] Specification
[Item(s) to be Amended] 0019
[Method of Amendment] Modification
[Proposed Amendment]
[0019] The motor control unit 5 consists of a current command generating means 18 and a PSM control means 51. The torque command generating means 18 is electric torque command value tauM* from the high Brit drive system control section 15. Gain conversion is carried out and a torque command is outputted to the torque command generating means 18. The PSM control means 51 performs dq shaft current control processing based on the torque command value, and the current detector 6, the magnetic pole location detection means 4 and each detection value of an encoder 3, and outputs the driving signal (PWM signal) of an inverter 2. The generation-of-electrical-energy control unit 9 consists of a generation-of-electrical-energy torque generating means 19 and a PSG control means 91. The generation-of-electrical-energy torque generating means 19 is generation-of-electrical-energy command KW[from the high Brit drive system control section 15] *. The generation-of-electrical-energy torque command (regeneration actuation) of a generator 7 is outputted based on a generator rotational frequency (not shown). detection of a PSG control means 91 generation-of-electrical-energy torque command and the current detector 10 is boiled also as a value, dq shaft current control processing is performed, and the driving signal of a converter 8 is outputted.
[Procedure amendment 3]
[Document to be Amended] Specification
[Item(s) to be Amended] 0020
[Method of Amendment] Modification
[Proposed Amendment]
[0020] The block diagram of the PSM control means 51 of the motor unit 5 is shown in drawing 3 . The PSM control means 51 is equipped with the IdIq detector 202, the IdIq current control means 204 / three-phase-circuit conversion means 206, the PWM control means 208 and the phase operation means 210, and the rate operation means 212. The rate operation means 212 is connected to an encoder 3, and the phase operation means 210 is connected to the magnetic pole location detection means 4. Furthermore efficient

control of the rate operation was carried out, and in order to generate optimal Iq* and Id* command value, it has the Iq control means 224 and the Id control means 226.
[Procedure amendment 4]
[Document to be Amended] Specification
[Item(s) to be Amended] 0021
[Method of Amendment] Modification
[Proposed Amendment]
[0021] Command value Iq* of q shaft current which is equivalent to a torque part current in the PS control means 51 is torque command value tauM*. It computes by the Iq control means 224 based on the rotational frequency of a motor 1. Similarly, it is command value Id* of d shaft current. Torque command value tauM* Based on the rotational frequency of a motor 1, it computes by the Id control means 226.
[Procedure amendment 5]
[Document to be Amended] Specification
[Item(s) to be Amended] 0023
[Method of Amendment] Modification
[Proposed Amendment]
[0023] Furthermore, in 2 / three-phase-circuit conversion means 206, 2 phases / three phase circuit carries out coordinate transformation, and they are three-phase-circuit alternating-voltage command value VU*, VV*, and VW*. It computes. the PWM control means 208 -- this electrical-potential-difference command value VU*, VV*, and VW* from -- comparison processing with the carrier signal of a triangular wave signal is performed, the PWM signal which is a driving signal of an inverter 2 is generated, and an inverter 2 is driven. Thus, by impressing the electrical potential difference by which PWM control was carried out to a motor 1, it is a motor current Current command value Iq* and Id* It controls.
[Procedure amendment 6]
[Document to be Amended] Specification
[Item(s) to be Amended] 0024
[Method of Amendment] Modification
[Proposed Amendment]
[0024] In addition, the phase angle theta 1 used by 2 / three-phase-circuit transform processing 206, and coordinate transformation processing of the IdIq detection means 202 is computed in the phase operation means 210 from the induced voltage of a motor 1, and each output of the magnetic pole position transducer 4 which outputs a signal in phase, and the encoder 3 which outputs an angle-of-rotation signal (pulse signal).

[Procedure amendment 7]
[Document to be Amended] Specification
[Item(s) to be Amended] 0025
[Method of Amendment] Modification
[Proposed Amendment]
[0025] The phase relation of the phase angle theta 1 over the output signal of this magnetic pole position transducer 4, the motor current I1, and induced voltage E0 is shown in drawing 5 . A phasing signal is calculated with a phase operation means 210 to accumulate the pulse signal of an encoder 3, and turns into a saw-tooth-wave-like signal. The magnetic pole position signal which is an output signal of the magnetic pole position transducer 4 is synchronized with the induced voltage E0 of a motor 1. By performing such processing, a motor 1 is torque command value tauM*. It is controlled by the well head which is torque and makes loss min.
[Procedure amendment 8]
[Document to be Amended] Specification
[Item(s) to be Amended] 0030
[Method of Amendment] Modification
[Proposed Amendment]
[0030] The torque characteristic which considered as the applied-voltage regularity to a motor, and made angle-of-lead beta adjustable is shown in drawing 7 . The sum of synchronous torque and reactance torque is generating torque tauM. Thus, since angle-of-lead beta generates the maximum torque near 45 degrees, the synchronous motor in which rho of (1) type has a larger reverse salient pole property than 1 is controlled above this include angle. An electric vehicle is driven in such actuation.
[Procedure amendment 9]

[Document to be Amended] Specification
[Item(s) to be Amended] 0031
[Method of Amendment] Modification
[Proposed Amendment]
[0031] Drawing 4 is the block diagram showing the example of a configuration of the PSG control means 91. It has the PSG control means 91, the IdIq detector 302, the IdIq current control means 304, the 2 / three-phase-circuit conversion means 306, the PWM control means 308 and the phase operation means 310, and the rate operation means 312. The input signal of the phase operation means 310 and the rate operation means 312 is alternatively connected to a zero detector 316 or 318 through the mode change means 314 which changes idling mode and generation-of-electrical-energy mode. It is alternating-voltage command value VU* whose zero detector 316 is the output of 2 / three-phase-circuit conversion means 306 at the time of generation-of-electrical-energy mode. A zero crossing point is detected. Moreover, a zero detector 318 detects the zero crossing point of the induced voltage of the generator obtained from the outgoing end 319 of a generator 7 in idling mode.
[Procedure amendment 10]
[Document to be Amended] Specification
[Item(s) to be Amended] 0032
[Method of Amendment] Modification
[Proposed Amendment]
[0032] Furthermore, it has the Iq control means 324 and the Id control means 326 which output Iq* and Id* command value. The generation-of-electrical-energy torque command generating means 19 is amount command KWof generations of electrical energy *. Based on the generator rotational frequency NG calculated with the rate operation means 312, generation-of-electrical-energy torque command tauG*=kxKW*/NG is generated. However, k is a constant.
[Procedure amendment 11]
[Document to be Amended] Specification
[Item(s) to be Amended] 0033
[Method of Amendment] Modification
[Proposed Amendment]
[0033] Command value Iq* of q shaft current which is equivalent to a torque part current in the PSG control means 91 Torque command value tauG* It computes by the Iq control means 324 based on the generator rotational frequency NG. Moreover, command value Id* of d shaft current Torque command value tauG* Based on the rotational frequency NG calculated with the rate operation means 312, it computes through the Id control means 326.
[Procedure amendment 12]
[Document to be Amended] Specification
[Item(s) to be Amended] 0034
[Method of Amendment] Modification
[Proposed Amendment]
[0034] The Iq control means 324 in the PSG control means 91 and the Id control means 326 are current command value Iq* required for efficient control, and Id* based on a rotational frequency NG. It computes. In addition, in this invention, the sensor loess control which is not used a rotation sensor (a magnetic pole position transducer and encoder) is adopted in consideration of the space factor to which circuitry was simply carried out and the engine room was restricted. That is, the rate NG of a generator 7 is not detected using a rotation sensor, but data processing of it is carried out as follows, and it is found. First, when a shift switch is in idling mode, an engine is an idling engine speed, suspends a converter 8 and does not perform generation-of-electrical-energy control. At this time, a phase operation and a rate operation are performed based on the zero detecting signal of the induced voltage of the generator obtained from the outgoing end 319 of a generator 7. While an engine becomes a rotational frequency higher than an idling engine speed, it changes to generation-of-electrical-energy mode, and generation-of-electrical-energy control is started. The phase operation means 310 is alternating-voltage command Vu*. A phase operation is performed based on a zero crossing point. Thus, alternating-voltage command Vu* which is the in-house data of dq shaft current control processing as a current control system of said AC generator Phasing signal theta 1 used by current control processing using a phasing signal It creates.
[Procedure amendment 13]
[Document to be Amended] Specification

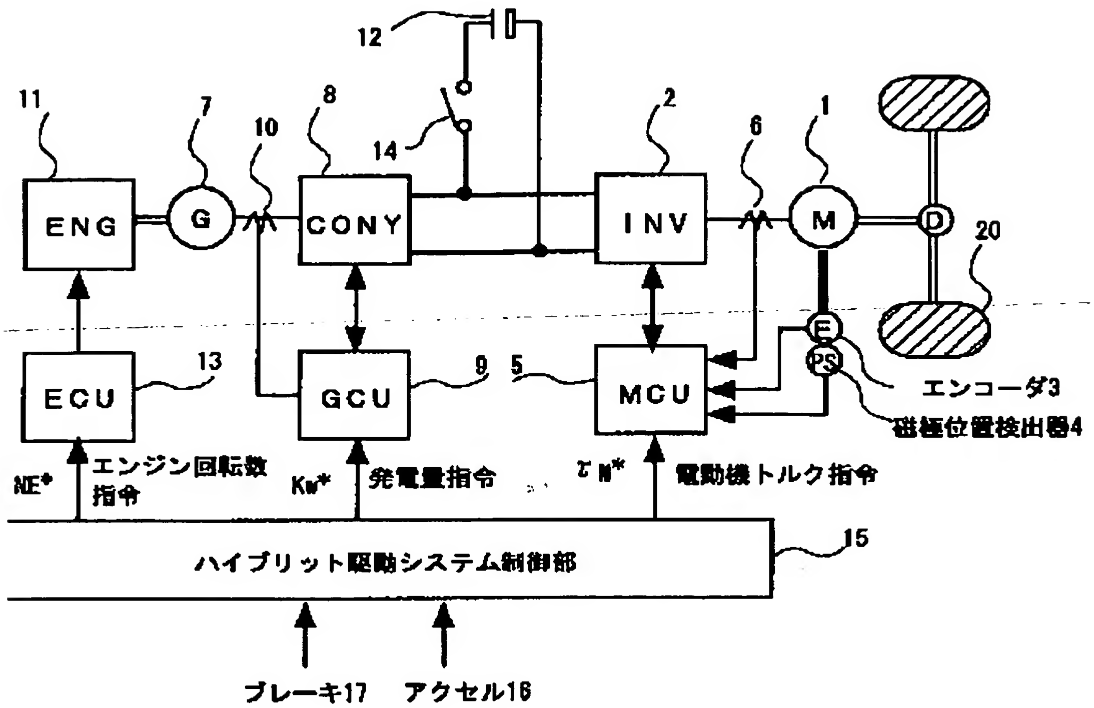
[Item(s) to be Amended] 0035
[Method of Amendment] Modification
[Proposed Amendment]
[0035] It computes d and the q shaft currents Id and Iq by a phasing signal theta 1 being used for the IdIq detection means 302 based on the three-phase-circuit alternating current of a generator current, and a three phase circuit/2 phase carrying out coordinate transformation. These detection values and command value Iq*, and Id* The IdIq current control means 304 performs proportionality or proportionality integral compensation processing on a basis, and they are electrical-potential-difference command value Vq* and Vd*. It computes.
[Procedure amendment 14]
[Document to be Amended] Specification
[Item(s) to be Amended] 0037
[Method of Amendment] Modification
[Proposed Amendment]
[0037] Next, actuation of sensor loess generator control is explained using drawing 10 from drawing 8 . The vector diagram of a generator 7 is shown in drawing 8 . A generator system makes regeneration actuation perform to a motor system, and charges a dc-battery 12. Therefore, by negative, angle-of-lead beta is 90 degrees or more in an electrical angle, and the q shaft current Iq operates. Furthermore, the generator terminal voltage V1 is behind only in the phase angle delta to induced voltage E0.
[Procedure amendment 15]
[Document to be Amended] Specification
[Item(s) to be Amended] 0038
[Method of Amendment] Modification
[Proposed Amendment]
[0038] As shown in drawing 9 , it is three-phase-circuit alternating-voltage command value VU*. The zero detection means 316 detects a zero crossing point. The phase operation means 310 computes the phasing signal theta 1 in which only the phase angle delta was to magnetic pole position signal PS-U (U phase signal) of imagination by amending a phasing signal theta 1 to theta11 and theta12 by zero crossing points t1 and t2. d shaft current control system of drawing 4 controls the generator current iu on the current to which only angle-of-lead beta (beta=ATAN (Id/Iq)) progressed to virtual signal PS-U, and makes generator control action perform based on this phasing signal theta 1.
[Procedure amendment 16]
[Document to be Amended] Specification
[Item(s) to be Amended] 0039
[Method of Amendment] Modification
[Proposed Amendment]
[0039] The phase angle delta is generation-of-electrical-energy torque command value tauG1* corresponding to [as shown in drawing 10 , calculate the value of the phase angles delta1 and delta2 beforehand from the amount P of generations of electrical energy and] the amounts p1 and p2 of generations of electrical energy, and tauG2*. Sensor loess generator control is attained by map-izing the phase angles delta1 and delta2 for the phase operation means 310. Therefore, this map is generation-of-electrical-energy torque command tauG*. It becomes the three-dimension map which outputs the phase angle delta by considering a rotational frequency NG as an input. In the phase angle property of drawing 10 , at the same rotational frequency, when small, the phase angle delta becomes [the amount P of generations of electrical energy] small like an arrow head. If the rotational frequency (min-1) of amount command KWof generations of electrical energy * and a generator is given, the phase angle delta will be called for by map retrieval. And a phasing signal theta 1, i.e., the phase of induced voltage E0, is presumed, and the reference signal of angle-of-lead beta used by control processing of current Iq* and Id* is computed.

[Procedure amendment 17]
[Document to be Amended] Specification
[Item(s) to be Amended] 0040
[Method of Amendment] Modification
[Proposed Amendment]
[0040] The vector diagram of the generator at this time is shown in drawing 8 . It is a generator current in order to always acquire an efficient point by each operation mode of power running or regeneration Current

command value Iq* and Id* It controls. Namely, Iq* and Id* It is controlled to be set to optimal angle-of-lead beta (beta=tan -1 (Id*/Iq*)). In addition, it is the reference point of angle-of-lead beta at the t0 presumed time shown in drawing 9 .
[Procedure amendment 18]
[Document to be Amended] Specification
[Item(s) to be Amended] 0041
[Method of Amendment] Modification
[Proposed Amendment]
[0041] Return and the hybrid drive system control section 15 are engine-speed command NE* to the engine control unit 13 in drawing 1 . It outputs, and it controls so that an engine becomes a predetermined rotational frequency. Moreover, it responds to the control input of the accelerator pedal 16, and is motor torque command tauM* to the motor control unit 5. It sends. Moreover, to the control input of the accelerator pedal 16, the condition of a dc-battery 12 is embraced and it is engine-speed command NE*. Amount command KWof generations of electrical energy * of the generator control unit 9 The control input of delivery and the accelerator pedal 16 operates a motor 1 in power running mode to each units 9 and 13 at an increment or the fixed time, and charges a dc-battery 12 at them, and the acceleration nature of a car is raised.
[Procedure amendment 19]
[Document to be Amended] Specification
[Item(s) to be Amended] 0043
[Method of Amendment] Modification
[Proposed Amendment]
[0043] In the case of for example, an PWM control system, also in an inverter 2, in this invention, the modulation technique of the power component of a converter 8 makes it the same modulation technique a passage clear from the example described above. Moreover, the generator control units 9 are the same configuration as the motor control unit 5, and a control system. That is, the motor control unit 5 and the generator control unit 9 are considered as dq shaft current control which makes the same the current control system of an AC motor and an AC generator, and shows a current control system of an excitation component and a torque component. By considering as the above configurations and control systems, the response of dq shaft current control system of both converters is made the same, or can be chosen as the property of arbitration. By performing the above configuration and actuation, it is possible to form into a high response the response of the generator control system which charges a dc-battery to the motor control system and EQC for a car drive.
[Procedure amendment 20]
[Document to be Amended] Specification
[Item(s) to be Amended] 0049
[Method of Amendment] Modification
[Proposed Amendment]
[0049] Drawing 13 shows the example which applied this invention to the parallel mold high Brit drive system configuration for electric rolling stock, and drives a car with the driving force of a gasoline engine, and the driving force of a motor drive system. 31 is a gearbox. It is possible by constituting, as the previous example described the motor control unit 5 and the generator control unit 9 also in this example to form into a high response the response of the generator control system which charges a dc-battery to the motor control system and EQC for a car drive.
[Procedure amendment 21]
[Document to be Amended] Specification
[Item(s) to be Amended] 0051
[Method of Amendment] Modification
[Proposed Amendment]
[0051] Moreover, the control system of the same above-mentioned main circuit configuration also becomes possible [forming further into a high response the response characteristic of the generator control system which charges a dc-battery] by supposing that it is the same. Moreover, it becomes possible to attain space-saving-ization of a hybrid drive system by considering as the sensor loess control which does not use the rotation sensor which constitutes the current control system of an AC generator from an encoder which is an angle sensor, or a magnetic pole location sensor.
[Procedure amendment 22]
[Document to be Amended] DRAWINGS

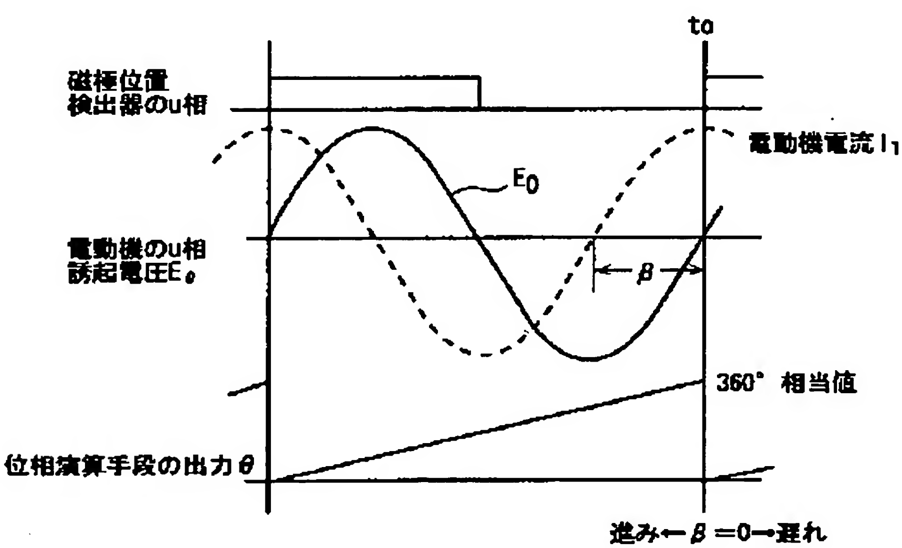
[Item(s) to be Amended] Complete diagram
[Method of Amendment] Modification
[Proposed Amendment]
[Drawing 1]

図 1



[Drawing 5]

図 5



[Drawing 2]

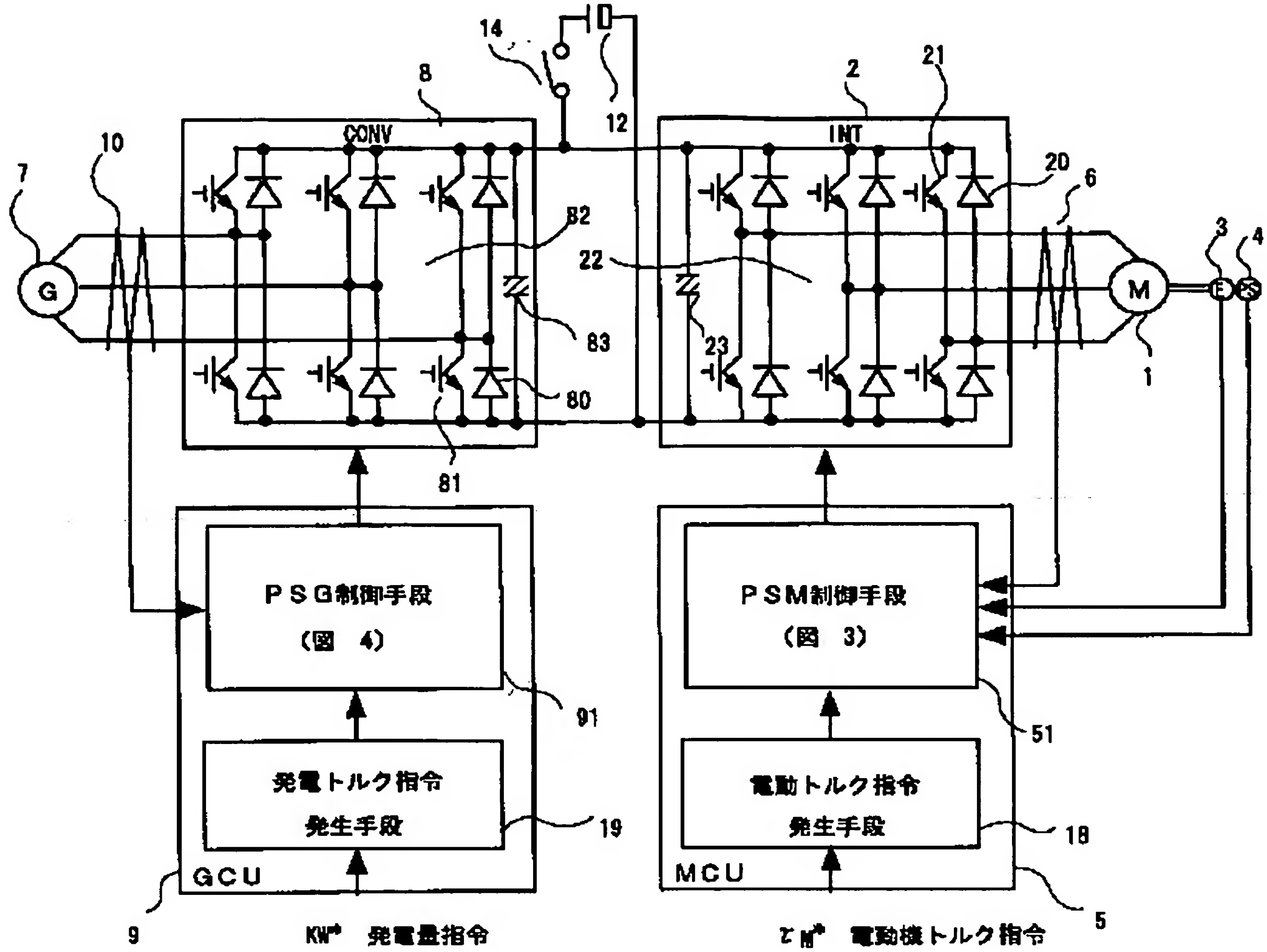
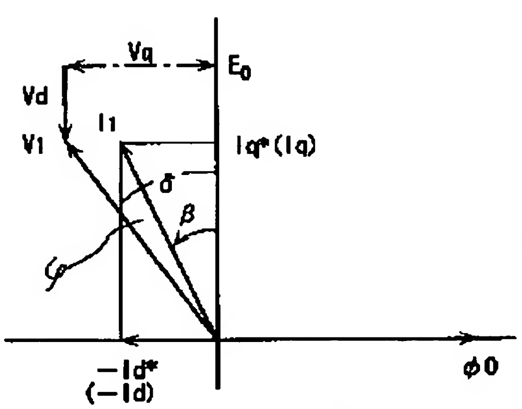


図 2

[Drawing 6]

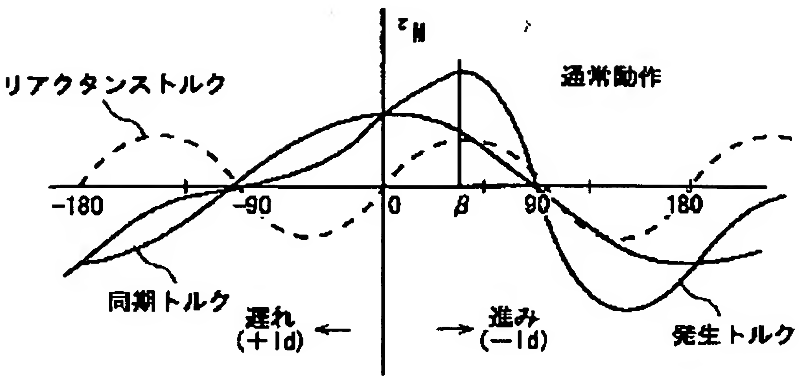
図 6



E_0…磁石の誘起電圧　V1…端子電圧
δ…負荷角　φ…力率角　β…進み角

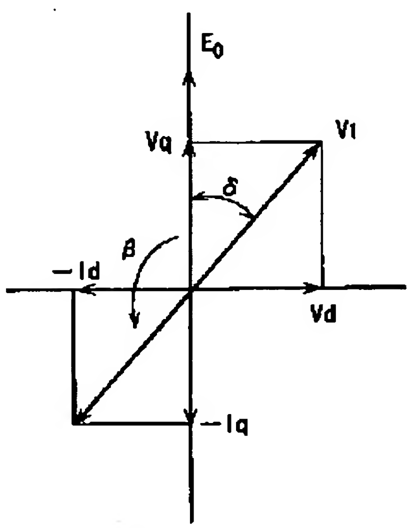
[Drawing 7]

図 7



[Drawing 8]

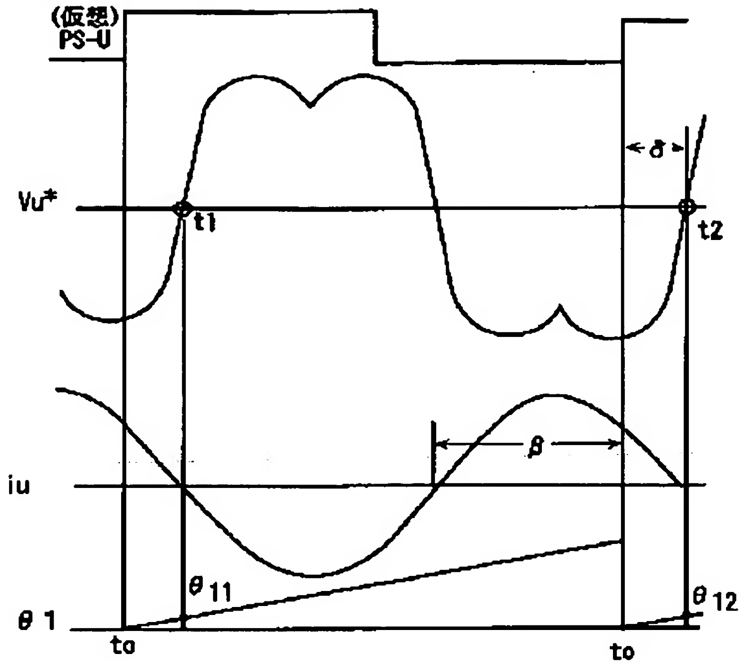
図 8



δ…相差角　β…進み角

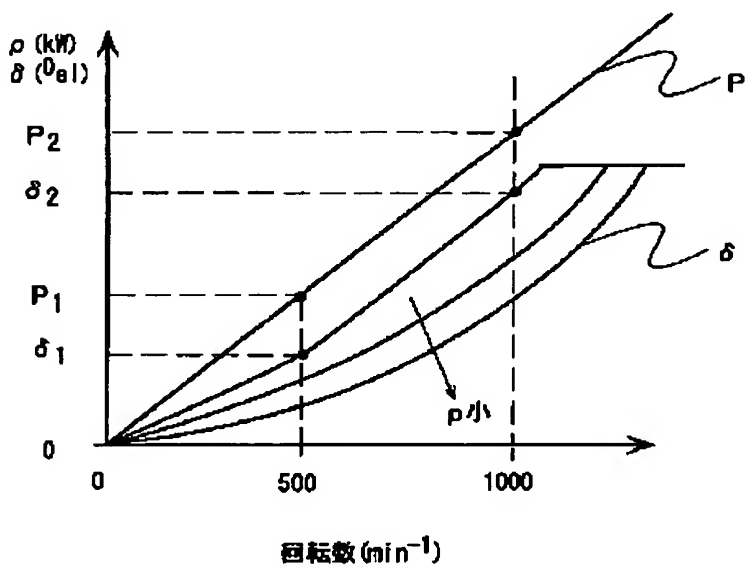
[Drawing 9]

図 9



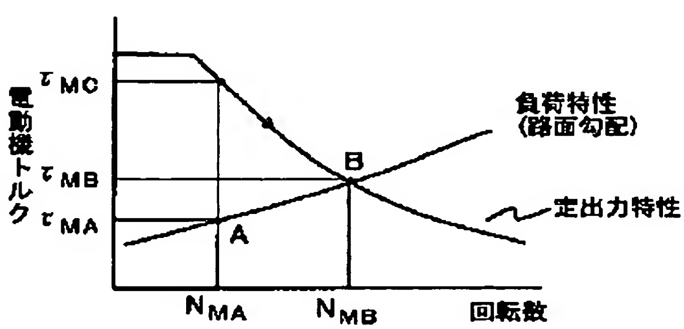
[Drawing 10]

図 10



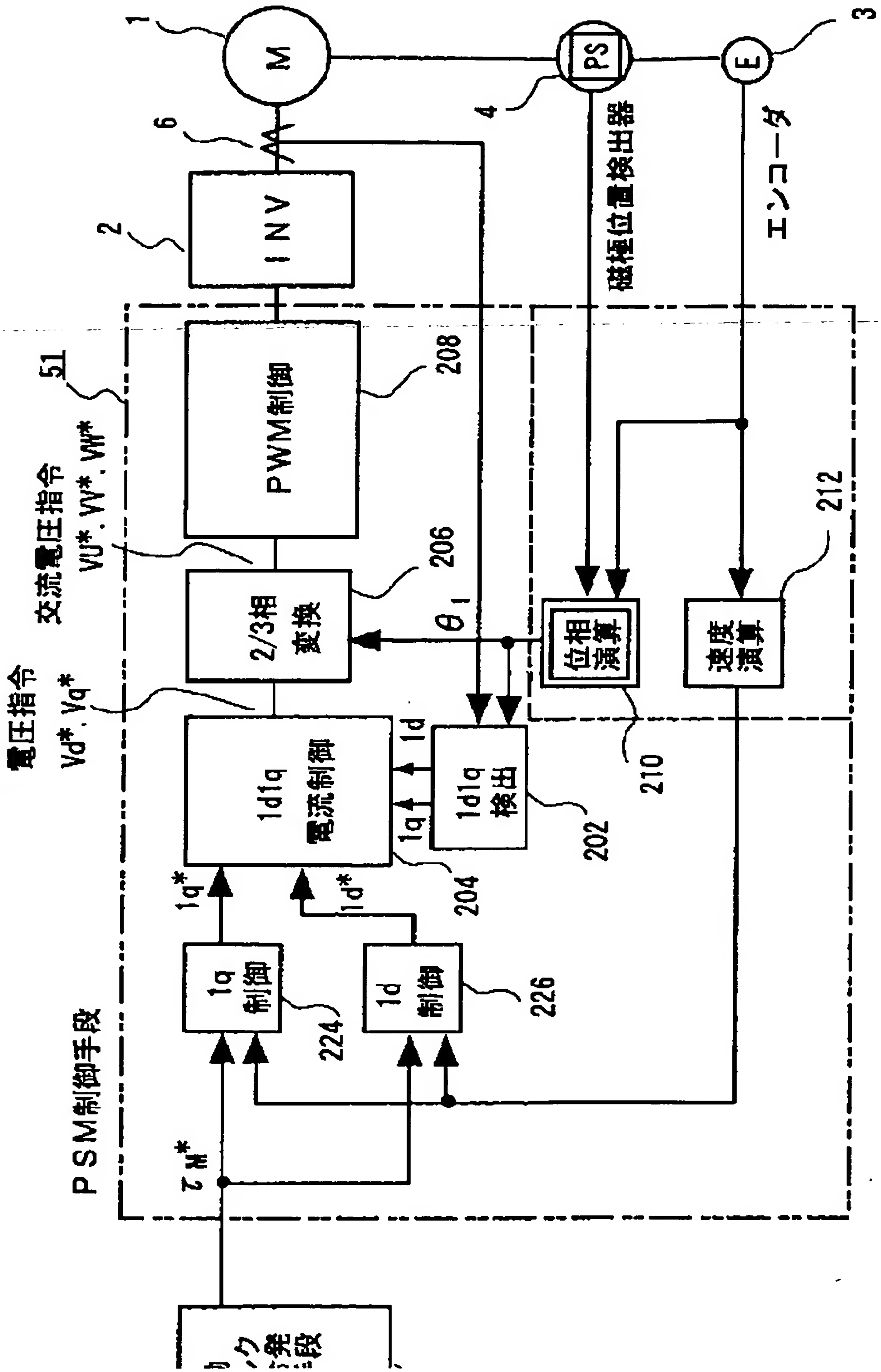
[Drawing 11]

図 11



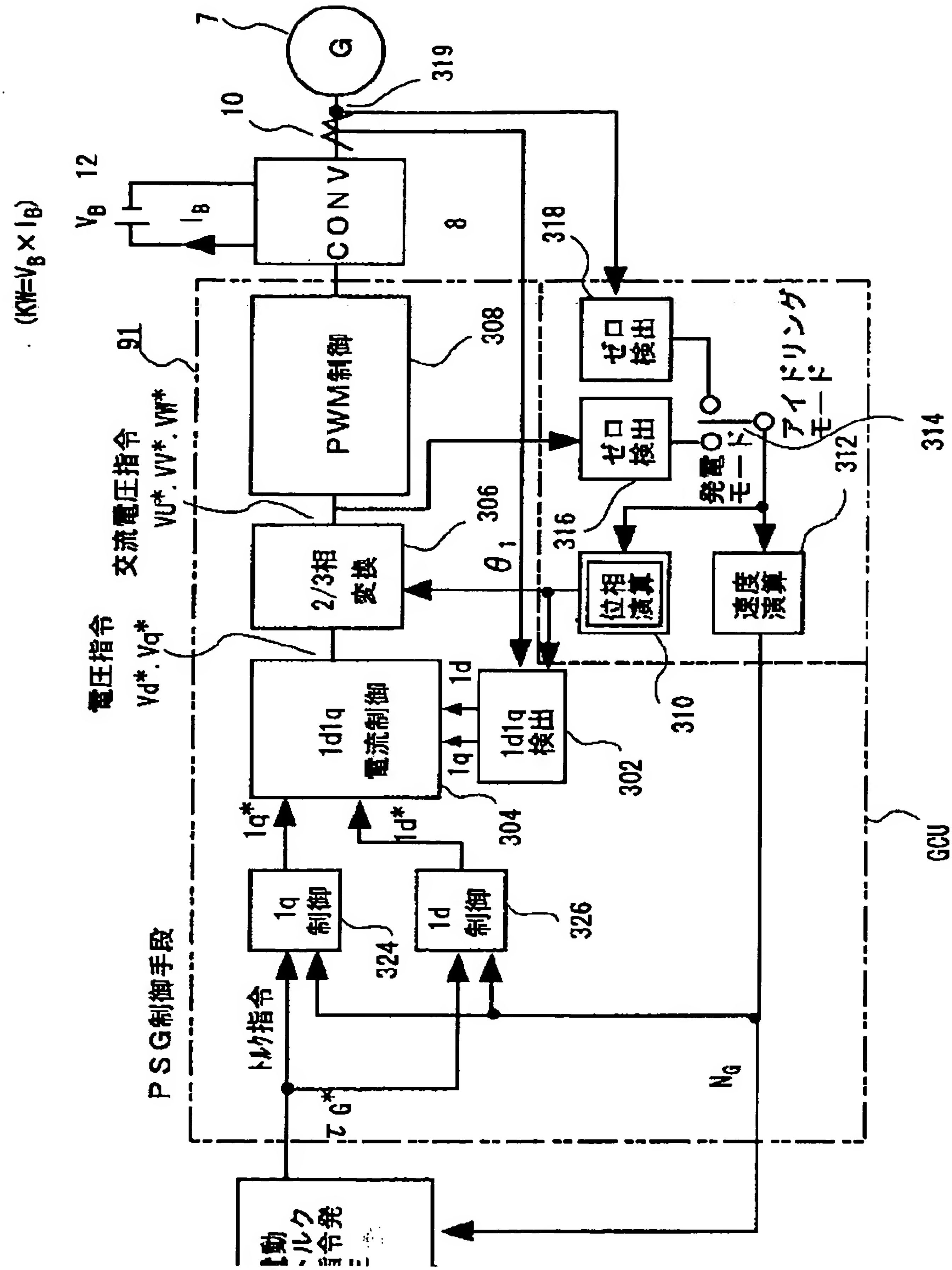
[Drawing 3]

図 3


1
M
6
2
INV
4
PS
3
E
磁極位置検出器
エンコーダ
51
交流電圧指令
VU*, VV*, VW*
PWM制御
208
206
2/3相
変換
θ1
位相
演算
速度
演算
212
210
電圧指令
Vd*, Vq*
IdIq
電流制御
Id
Iq
IdIq
検出
202
204
Iq*
Id*
Iq
制御
Id
制御
224
226
PSM制御手段
τM*

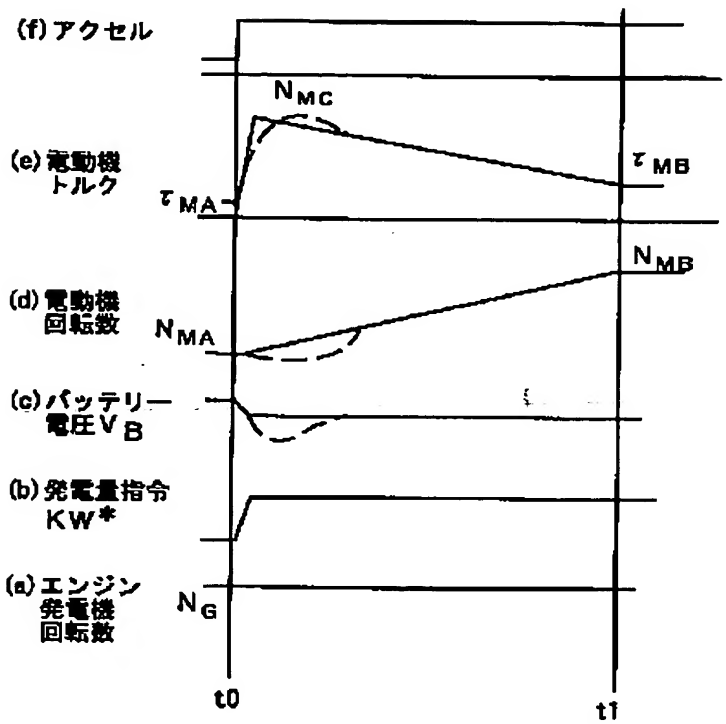
[Drawing 4]

図 4


7
G
319
10
CONV
12
V_B
I_B
(KW=V_B×I_B)
8
91
PWM制御
308
交流電圧指令
VU*, VV*, VW*
306
2/3相変換
θ_1
318
ゼロ検出
ゼロ検出
アイドリングモード
314
発電モード
316
312
位相演算
速度演算
310
電圧指令
Vd*, Vq*
1d1q電流制御
1d
1q
1d1q検出
302
304
1q*
1d*
1q制御
1d制御
324
326
GCU
PSG制御手段
トルク指令
τG*
N_G

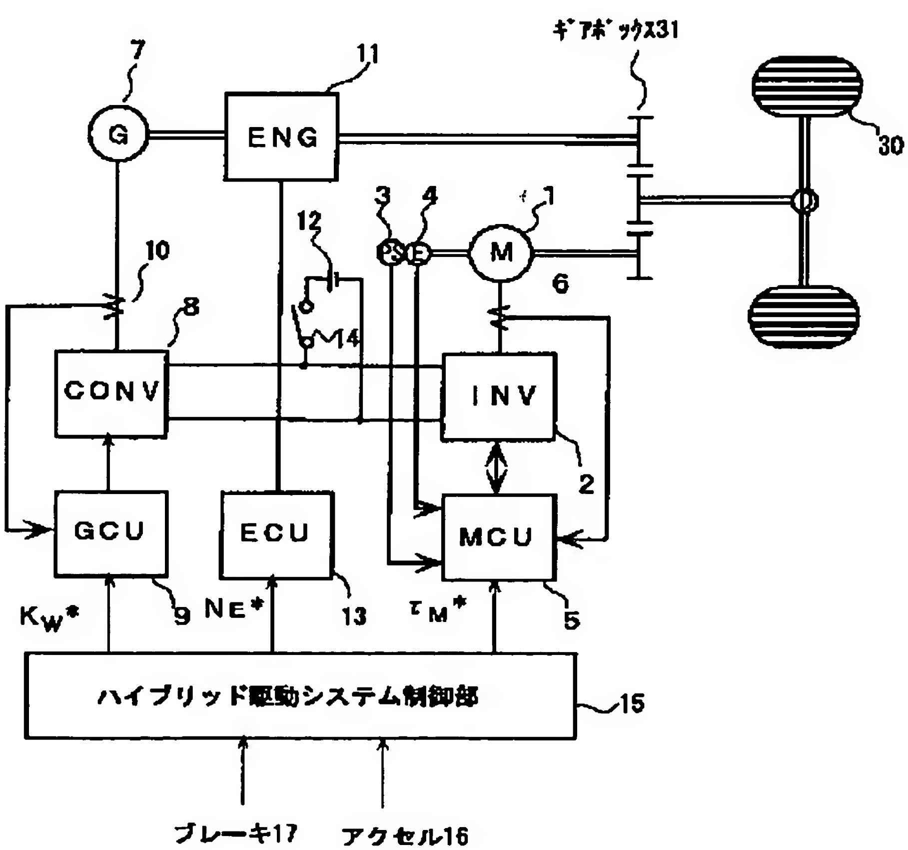
[Drawing 12]

図 12



[Drawing 13]

図 13



[Translation done.]